Low-background Counting Facilities

A.R. Smith, D.L. Hurley, R.J. McDonald, and E.B. Norman

The LBNL Low Background Facilities (LBF) consist of a Berkeley site and an Oroville site specially configured for low-background gamma-ray spectroscopy. The Berkeley site was established in 1963 and consists of a 3m by 7m x 3m room surrounded by 1.6m of specially selected low-background concrete shielding. The aggregate in this concrete is from serpentine gravel, which is low in U, Th, and K. This barrier was made to shield against accelerator-produced neutrons and natural gamma radiation as well as some cosmic rays. Also, the low-activity concrete emits little radon, and a HEPA-filtered air system constantly purges the room to reduce airborne radon daughter activity

Detectors at Berkeley include a 20 cm diameter by 10 cm thick NaI crystal, one 115% n-type Ge-spectrometer, one 30% p-type Ge spectrometer and two 80% p-type Ge-spectrometers, one of which is available for field work. Detectors each have small local shields of 10 cm thick Pb. This shielding reduces background to the point where cosmic rays and activity within a detector assembly dominate the residual background.

The Oroville LBF is located in the powerhouse of the Oroville Dam, under 180-m of rock cover. This site now has one 80% p-type Ge-spectrometer, and one or two 30% p-type Ge-spectrometers, depending on the work load. This site is used for our most sensitive counting, particularly for certification of materials. Sensitivities of 50 parts-per-trillion (PPT) for U and daughters, 200 PPT for Th and daughters, and 100 parts-per-billion for K are realized at the Oroville site. The Oroville LBF was utilized 100% of this year analyzing samples that required its ultra-low background environment.

The LBF continues to be involved in a wide variety of experiments supporting programs in basic and applied science at LBNL and a variety of other institutions. This year, work mainly involved: 1) low-activity materials certification for CDMS, and KamLAND, 2) neutron activation, 3) neutron flux measurements, and 4) environmental health and safety activities.

The neutron activation program continued with work involving the fabrication of NTD Ge thermistors for the CUORE experiment in Italy as well as tests of materials for CDMS.

Work has begun on the Bevalac decommissioning. Current studies involve counting both concrete and steel components of the main accelerator structure in order to determine the scope of disposal of radioactive components

The facility is a participant in development of a relativistic electron accelerator based on the laser Wakefield effect. The LBF provides diagnostic information with respect to beam energy and angular distribution by analysis of radioactivities induced in special target arrays. We have confirmed the acceleration of electrons to at least 20 MeV over a distance of less than 2 mm.

Data taken at Oroville with a CCD array being developed by an LBNL/UCSC collaboration has for the first time clearly identified the major components of background in these devices. Data taken at the Bldg 72 LBF clearly characterized the response of these devices to gamma-rays over the energy range of interest

The facility is now involved with three major projects in neutrino and dark matter physics: 1) the second generation Cold Dark Matter Search, for which we provide materials certification. 2) The KamLAND neutrino experiment, also involving material certification, and 3) the CUORE experiment in the Gran Sasso in Italy. CUORE involves the facility in neutron activation, materials studies, and cryogenic detector technology. Facility scientists have also become involved in other aspects of this experiment including crystal polishing, tower assembly, and neutron shielding. A nuclear reactor at MIT is being investigated for use in transmutation doping of Ge to produce the thousands of thermistors needed for CUORE The MIT neutron beam is more highly thermalized than the beam at the (previously used) Univ. of Missouri reactor, and so should produce fewer high-energy reaction products that can compromise thermistor performance.